

Retinotomy and Retinectomy in the Management of Rhegmatogenous Retinal Detachment Associated with Advanced Proliferative Vitreoretinopathy

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Abstract

Purpose: To report the anatomical and functional outcomes of retinotomy and/or retinectomy for the management of rhegmatogenous retinal detachment (RRD) complicated by advanced proliferative vitreoretinopathy (PVR).

Methods: In this retrospective study, the charts of patients who underwent pars plana vitrectomy with retinotomy and/or retinectomy for the management of RRD complicated by PVR were reviewed. Primary outcome measures were final best-corrected visual acuity (BCVA) and anatomical reattachment rate.

Results: Sixty-one eyes of 61 patients with a mean age of 48.56 ± 15.92 were studied. The mean follow-up time was 21.38 ± 23.08 months. The mean angle of the retinotomy was $171.31^\circ \pm 79.15^\circ$. Thirty-two (52.5%) of them needed extensive ($\geq 180^\circ$) retinotomy. In addition, simultaneous retinectomy was performed in 36.2% of the cases. The BCVA was 2.18 ± 0.63 and 1.85 ± 0.71 logMAR before the surgery and at the last visit, respectively ($P = 0.001$). The initial anatomical success was achieved in 45 eyes (73.8%) after retinotomy surgery. Sixteen eyes (26.2%) had recurrent RD and needed reoperation, which was performed 5.60 ± 4.01 months after the initial retinotomy surgery. At the last examination, the retina was attached in all patients.

Conclusion: Retinotomy with/without retinectomy is an effective procedure in the majority of patients with RRD associated with advanced PVR; however, additional surgeries are needed in a significant number of eyes to achieve final anatomical success.

Keywords: Proliferative vitreoretinopathy, Retinectomy, Retinotomy, Rhegmatogenous retinal detachment

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INTRODUCTION

Proliferative vitreoretinopathy (PVR) is characterized by cellular proliferation over and under the retina, leading to the formation of the epiretinal membranes, intraretinal fibrosis, and subretinal bands. PVR is the main reason of redetachment following successful surgery for rhegmatogenous retinal detachment (RRD). Various conditions such as trauma,

large retinal breaks or giant retinal tears, and chronic retinal detachment are correlated with an increased risk of PVR.^{1,2}

Complete pars plana vitrectomy (PPV) and meticulous membrane peeling are necessary for successful management of PVR; however, residual traction or retinal shortening may lead to failure of the surgery for PVR. To achieve anatomical success in

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these cases, relaxing retinotomies with/without retinectomies are often required. The procedure includes incision of the contracted retina, typically in the peripheral area to facilitate the attachment of normal retina, supported by silicon oil or long-standing gas tamponade with/without an encircling band.³⁻⁶

The purpose of this study was to evaluate the anatomical and visual outcomes in the eyes that underwent retinotomy with/without retinectomy during PPV for RRD-associated advanced PVR.

METHODS

This was a noncomparative retrospective study that was conducted based on patients' chart reviews from 2010 to 2018 in Rassoul Akram Hospital, Tehran, Iran. Patients with RRD associated with advanced PVR (grade C) who underwent retinotomy and/or retinectomy during their PPV surgery was included. The PVR grading was based on the updated Retina Society Classification system.⁷ Patients with <3 months of the follow-up period, age <18 years, nonrhegmatogenous types of RD, and ocular inflammatory diseases were excluded. For all patients, best-corrected visual acuity (BCVA) measurement, slit-lamp biomicroscopy, checking intraocular pressure (IOP) by Goldmann tonometry, and fundus indirect ophthalmoscopy were performed at baseline and follow-up visits. The Ethics Committee of the Iran University of Medical Sciences approved the study (Ethics Committee code: IR.IUMS.REC.1397.622).

The four experienced vitreoretinal surgeons (K.G.F., M.M.P., A.S., F.A.) performed the surgeries. The surgery included standard PPV, including complete posterior vitreous removal and peripheral vitreous shaving. All preretinal membranes were peeled by micro forceps. Subretinal membranes were removed if it was necessary. Simultaneous scleral buckling (SB) surgery (placement of an encircling band, No. 240) was performed at the surgeon's discretion. The retinotomy was performed as the last option when the retinal contracture or shortage prevented successful retinal reattachment. The retinectomy was performed anterior to the retinotomy when the retinotomy was significant and peripheral. The retinal reattachment was achieved by using perfluorocarbon liquid and silicone oil injections. Intraoperative complications, including iatrogenic retinal breaks and hemorrhages, were recorded.

All patients were followed up for at least 3 months after the surgery. The primary outcome measure was anatomical success (single surgery retinal reattachment rate), and the secondary outcome was functional (BCVA) success after the first surgery.

Statistical analysis

Data were analyzed using SPSS software version 24 (SPSS Inc., Chicago, IL, USA) and presented in form of mean \pm standard deviation for continuous, and percentage for categorical variables. Data were analyzed using Fisher's exact test to assess categorical cross-distributions, and Wilcoxon signed-rank test to compare within groups. Multiple linear regression analysis was performed to evaluate the relationship and predictability

of some independent variables on the recurrent RD as the dependent variable. A value of $P < 0.05$ was considered statistically significant.

RESULTS

In total, 61 eyes of 61 patients were enrolled. Of them, 41 (67.2%) were male. The mean age was 48.56 ± 15.92 (range, 18–76) years. In 33 eyes (54.1%), the macula was detached. The mean follow-up time was 21.38 ± 23.08 (range, 3–84) months. Before the surgery, 26 eyes (42.6%) were phakic, 25 (41.0%) were pseudophakic, and 10 (16.4%) of them were aphakic. At baseline, 32 eyes (52.5%) had a history of prior RD surgery, including 26 eyes (42.6%) who had undergone previous PPV, 4 eyes (6.6%) with previous SB, and 2 eyes (3.3%) with previous PPV + SB. Preoperative BCVA was $\leq 6/30$ in all eyes with a mean of 2.18 ± 0.63 logMAR. Baseline characteristics are summarized in Table 1.

The intraoperative factors are summarized in Table 2. Thirty-four eyes (55.7%) had SB surgery, and 21 eyes (34.4%) had phacoemulsification during the PPV surgery. Retinotomy was performed in all eyes. The mean angle of the retinotomy was 171.31 ± 79.15 (range, 90–360°). Thirty-two (52.5%)

Table 1: Baseline patients and ocular characteristics

	<i>n</i> (%)
Age (years), mean \pm SD (range)	48.56 \pm 15.92 (18–76)
Sex	
Male	41 (67.2)
Female	20 (32.8)
BCVA (logMAR), mean \pm SD (range)	2.18 \pm 0.63 (0.70–3.00)
Lens status	
Phakic	26 (42.6)
Aphakic	10 (16.4)
Pseudophakic	25 (41.0)
RRD quadrants	
One quadrant (19 of them at the inferior quadrant)	24 (39.3)
Two quadrants	5 (8.2)
Three quadrants	7 (11.5)
Four quadrants	25 (41.0)
Macular status	
Detached	33 (54.1)
Attached	28 (45.9)
PVR classification (Grade C)	
Posterior (C _p 1–12)	12 (19.7)
Anterior (C _a 1–12)	49 (80.3)
Prior operations	
PPV	26 (42.6)
SB	4 (6.6)
PPV+SB	2 (3.3)
Crystalline lens extraction	35 (57.4)

SD: Standard deviation, *n*: Number, SD: Standard deviation, BCVA: Best-corrected visual acuity, RRD: Rhegmatogenous retinal detachment, PVR: Proliferative vitreoretinopathy, C_p 1–12: Grade C, type posterior, 1–12 clock hours, C_a 1–12: Grade C, type anterior, 1–12 clock hours, PPV: Pars plana vitrectomy, SB: Scleral buckling

Table 2: Intraoperative factors in eyes underwent retinotomy/retinectomy

	<i>n</i> (%)
Procedures in addition to vitrectomy	
SB	34 (55.7)
Lensectomy	21 (34.4)
Relaxing retinotomy location	
Inferior	35 (57.4)
Temporal	11 (18.0)
Superior	4 (6.6)
Nasal	3 (4.9)
All quadrants	7 (11.5)
Missing	1 (1.6)
Relaxing retinotomy size (°), mean±SD (range)	171.31±79.15 (90–360°)
<180	29 (47.5)
≥180	32 (52.5)
Simultaneous retinectomy	19 (31.1)
Intraocular tamponade	
Silicone oil	61 (100)
Intraoperative complications	
Iatrogenic retinal breaks	13 (21.3)
Intraoperative hemorrhage	0

n: Number, SB: Scleral buckling, SD: Standard deviation

eyes needed extensive (≥180°) retinotomy. Simultaneous retinectomy was performed in 19 eyes (31.1%).

There was no statistically significant difference for extensive retinotomy (≥180°) between preoperative anterior (27 of 49, 55.1%) and posterior (5 of 12, 41.7%) grades of PVR ($P = 0.304$).

Intraoperative extensive hemorrhagic complications were not reported in any eye. All of the eyes received silicone oil as intraocular tamponade.

After the first retinotomy surgery, the retina reattachment was achieved in 55 eyes, in the 1-month follow-up visit. From them, 45 eyes (73.8% of 61) remained attached (including both peripheral retina and macula together) during the next follow-up visits. RD recurred in 16 eyes (including 6 eyes with recurrent RD at month 1 and 10 eyes with recurrent RD in the next follow-up visits, 26.2% of 61) with the mean time of 5.60 ± 4.01 (range, 1–14) months after the initial retinotomy surgery. In all eyes with recurrent RD, reattachment was achieved with the second surgery, and the retina remained attached during the mean follow-up of 13.80 ± 20.95 (range, 0–79) months after that. The mean follow-up time in this study was 21.38 ± 23.08 (range, 3–84) months from the initial surgery. In the multivariate analysis by multiple linear regression test, history of previous retinal surgery, lens status, RRD location, grade of PVR, number of posterior or anterior PVR clock hours, extension or location of retinotomy, SB surgery (in addition to PPV), and postoperation IOP did not have statistically significant relationships with the occurrence of recurrent RD [All $P > 0.05$, Table 3].

The final BCVA was 1.85 ± 0.71 (range, 0.50–3.00) logMAR at the last follow-up visit and increased significantly ($P = 0.001$, Wilcoxon signed-rank test) in comparison to the baseline (2.18 ± 0.63 logMAR). In the multivariate analysis by multiple linear regression test, the extension, and the location of retinotomy did not have statistically significant relationships with the BCVA changes ($P = 0.299$, and $P = 0.214$, respectively).

Two eyes (3.2%) had postoperative IOP of < 8 mmHg during follow-ups. However, both of these eyes were hypotonic before the surgery.

Further vitrectomy (the second operation) was performed in all eyes with recurrent RD (16 out of 61, 26.2%). In these eyes, the macula was detached in all cases.

In 21 eyes (34.4%), the silicone oil removal was performed after a mean time of 6.90 ± 5.29 (range, 1–21) months from silicone oil injection. Indications for silicone oil removal were secondary glaucoma, keratopathy, silicone oil emulsification, and the surgeon's preference. Retina remained attached during at least 6 months of additional follow-up visits in all of these eyes.

DISCUSSION

Retinotomy is used to relax intractable tractions and facilitate the retinal opposition to the retinal pigment epithelium. These tractions may be seen in PVR, proliferative diabetic retinopathy, retinal incarceration, and situations with loss of retinal elasticity like high myopia.^{6,8-14} The retinotomy with/without retinectomy should be performed after complete membrane removal, because excessive retinotomy may lead to large retinal defects and subsequent retinal redetachment.³ In our study, the retinotomy was performed in RRD-associated advanced PVR (grade C_p or C_A) eyes during PPV surgery. In these patients after complete membrane removal, the retinotomy was performed due to retinal contracture or shortage preventing successful retinal reattachment. Relaxing retinotomy has been known as an effective surgical technique during vitrectomy in eyes with RD-associated advanced PVR.³ In this study, we evaluated the anatomical and functional outcomes of this surgical technique with its possible complications to assess the role of this technique in patients with RRD-associated advanced PVR.

In this study, 45 of 61 eyes (73.8%) achieved successful retinal attachment (as initial anatomical outcome) after the initial retinotomy surgery. After additional surgeries (due to recurrent RD after the initial retinotomy surgery), the final retinal reattachment (as the final anatomical outcome) was achieved in all eyes. The initial and final anatomical success rates are comparable with other similar previous studies [Table 4].^{3,6,9-12,15-28} These differences may be attributed to the differences in patients' age, follow-up duration, the extent of retinotomy in the primary procedure, grade and extent of PVR, and mechanism of RD.

Table 3: Distribution of retinal redetachment rate after the initial retinotomy surgery according to ocular characteristics and intraoperative factors

Variable	Retinal redetachment after the initial retinotomy surgery		P (multiple linear regression test)
	No (n=45), n (%)	Yes (n=16), n (%)	
History of previous retinal surgery			
No	22 (48.9)	6 (37.5)	0.756
Yes	23 (51.1)	10 (62.5)	
Lens status			
Phakic	19 (42.2)	7 (43.8)	0.783
Pseudophakic	19 (42.2)	6 (37.5)	
Aphakic	7 (15.6)	3 (18.7)	
RRD location			
Inferior	13 (28.9)	6 (37.5)	0.671
Temporal	1 (2.2)	1 (6.3)	
Superior	0	1 (6.3)	
Nasal	1 (2.2)	1 (6.3)	
Two quadrants	5 (11.1)	0	
Three quadrants	7 (15.6)	0	
Four quadrants	18 (40.0)	7 (43.7)	
Grade of PVR			
Anterior	37 (82.2)	12 (75.0)	0.643
Posterior	8 (17.8)	4 (25.0)	
Number of posterior PVR clock hours, mean±SD (range)	5.26±3.58 (1-12)	5.64±2.50 (3-12)	0.967
Number of anterior PVR clock hours, mean±SD (range)	5.82±2.89 (1-12)	5.67±2.43 (3-12)	0.857
Extension of retinotomy			
<180	21 (46.7)	8 (50.0)	0.802
≥180	24 (53.3)	8 (50.0)	
Location of retinotomy			
Inferior	25 (55.5)	10 (62.5)	0.671
Temporal	9 (20.0)	3 (18.7)	
Superior	3 (6.7)	1 (6.3)	
Nasal	1 (2.2)	2 (12.5)	
Four quadrants	7 (15.6)	0	
SB surgery (in addition to PPV)			
No	19 (42.2)	8 (50.0)	0.852
Yes	26 (57.8)	8 (50.0)	
Postoperation IOP (mmHg), mean±SD (range)	15.56±5.32 (0-30)	13.44±5.34 (0-22)	0.553

n: Number, RRD: Rhegmatogenous retinal detachment, SD: Standard deviation, PVR: Proliferative vitreoretinopathy, SB: Scleral buckling, PPV: Pars plana vitrectomy, IOP: Intraocular pressure

Our results showed that the BCVA was significantly improved at the last follow-up visit in comparison to the baseline. Similar to this study, previous studies reported the final BCVA improved or at least remained stable in majority of the patients.^{3,26}

Some previous studies showed that the size and location of retinotomy have no statistically significant effect on the rate of anatomic reattachment and final BCVA.^{3,15,20} In contrast, other studies showed retinotomy size is a risk factor against recovering visual function.^{5,26} In addition, excessive retinotomy may lead to large retinal defects or residual membranes and increases the likelihood of retinal redetachment.³ Hence, our preference was less aggressive retinotomy incisions. Here, we revealed the location and extension of retinotomy have no statistically significant effects on the rate of initial anatomical success and the BCVA changes. However, the postoperative anatomical and

functional outcomes must be interpreted with consideration of the extent and severity of the baseline condition.²⁰

Previous studies revealed that tamponade with silicone oil has higher initial anatomic success rates than other tamponades (e.g., gas) in eyes that underwent retinotomy.^{23,25,26} Furthermore, some studies showed higher rates of postoperative hypotony in eyes with gas tamponade compared with silicone-injected eyes.⁹ Therefore, in this study we used silicone oil as the standard of care in all eyes.

Eyes with PVR are susceptible for hypotony after vitrectomy surgery.^{5,6,8,20-22,29-31} In addition, retinotomy incisions can expose bare retinal pigment epithelium, leading to absorption of intraocular fluid and subsequent ocular hypotony.¹ In this series, two hypotonic eyes (3.2%) remained hypotonic after the surgery during follow-ups.

Table 4: Review of literature in the last two decades: retinotomy in the management of rhegmatogenous retinal detachment with advanced proliferative vitreoretinopathy

Trial (first author, year, location)	Eyes (patients)	Months of follow-up (range)	Age, year (range); male (%)	PVR classification	SB procedure, n (%)	Type of tamponade, n (%)	Anatomical success rate after first retinotomy surgery, n (%)	Final anatomical success rate, n (%)	Major intraoperative complications, n (%)
Naz <i>et al.</i> , 2018, Pakistan ⁴	40 (40)	6 (6-24)	51.5 (18-65); 72.5	C _p : 36 (90.0) C _A : 4 (10.0)	0 (0)	SO: 40 (100)	29 (72.5)	39 (97.5)	Not reported
Adhi, 2017, Pakistan ¹⁹	370 (337)	39 (6-168)	42 (5-85); 66.8	C _p : 126 (34.1) C _A : 244 (65.9)	90 (24.3)	SO: 302 (81.6) Gas: 68 (18.4)	311 (84.1)	344 (93.0)	Intraoperative bleeding: 80 (21.6) Iatrogenic retinal breaks: 48 (13.0)
Hocaoglu, 2016, Turkey ²⁷	24 (24)	51.5 (6-152)	44.2 (19-72); 68	The details was not mentioned	Prior: 5 (20.8) Simultaneous: 4 (16.7)	SO: 24 (100)	Not reported	19 (79.2)	Not reported
Garnier, 2013, France ¹⁸	20 (20)	58 (25-78)	38 (18-53); 85	C _A : 20 (100)	Prior: 9 (45.0) Simultaneous: 0 (0)	SO: 20 (100)	Not reported	14 (70.0)	Not reported
Kimura, 2012, Japan ¹⁷	19 (19)	41 (7-64)	44.6 (11-73); 52.6	C _p : 3 (15.8) C _A : 16 (84.2)	Prior: 5 (26.3) Simultaneous: 11 (57.9)	SO: 19 (100)	15 (78.9)	19 (100)	Not reported
Shalaby, 2010, Egypt/Saudi Arabia ³	38 (38)	20.6 (6-29)	56.6 (18-76); 52.6	C _p : 18 (47) C _A : 26 (68.4)	Prior: 10 (26.3) Simultaneous: 15 (39.5)	SO: 25 (65.8), SF ₆ : 3 (7.9) C ₃ F ₈ : 10 (26.3)	29 (76.3)	34 (89.5)	Intraoperative bleeding: 10 (26.3) Iatrogenic retinal breaks: 9 (23.7)
Tsui, 2009, US ²¹	41 (41)	37 (6-126)	62 (20-78); 44.0	C _A : 41 (100)	Prior: 39 (95.1) Simultaneous: 2 (4.9)	SO: 41 (100)	Not reported	37 (90.2)	Not reported
Lim, 2009, Malaysia ²⁸	30 (30)	6	58.5 (28-86); 63.3	C _p and C _A : The details was not mentioned	Prior: The details of prior surgeries was not mentioned Simultaneous: 0 (0)	SO: 30 (100)	27 (90.0)	28 (93.3)	Not reported
Grigoropoulos, 2007, UK ²⁶	304 (302)	20 (3-78)	60 (4-94); 61.9	C _p : 190 (62.5) C _A : 80 (26.3) Not documented: 34 (11.2)	Prior: 123 (40.5) Simultaneous: 6 (2.0)	SO: 300 (98.7) Gas: 4 (1.3)	156 (51.3)	219 (72.0)	Not reported
Quiram, 2006, US ²⁵	56 (56)	25 (6-70)	62 (19-87); 60.0	C _A : 56 (100)	Prior: 31 (55.4) Simultaneous: 18 (32.1)	SO: 45 (80.4) Gas: 11 (19.6)	34 (60.7)	52 (92.9)	Not reported
Tseng, 2005, US ²⁰	81 (80)	20.6 (3-69)	62.6 (27-92); 58.8	C _A : 65 (80.2) C _p : 16 (19.8)	Prior: 62 (76.5) Simultaneous: 19 (23.5)	SO: 47 (58.0) Gas: 34 (42.0)	65 (80.2)	80 (98.8)	Intraoperative bleeding: 3 (3.7) Iatrogenic retinal break: 19 (22.5) Retinal dialysis: 3 (3.7)
Current study	61 (61)	21.4 (3-84)	48.6 (18-76); 67.2	C _A : 49 (80.3) C _p : 12 (19.7)	Prior: 6 (9.8) Simultaneous: 34 (55.7)	SO: 61 (100)	45 (73.8)	61 (100)	Intraoperative bleeding: 0 (0) Iatrogenic retinal break: 13 (21.3)

n: Number, PVR: Proliferative vitreoretinopathy, SB: Scleral buckle, SO: Silicone oil, SF₆: Sulfur hexafluoride gas, C₃F₈: Perfluorocarbon gas, C_p: Proliferative vitreoretinopathy grade C posterior to the equator, C_A: Proliferative vitreoretinopathy grade C anterior to the equator

In our series, concurrent SB procedure was performed for 34 eyes (totally 40 eyes had SB considering 6 eyes with prior SB procedure). Although SB can provide additional support in inferior detachments and anterior PVR, some studies suggested that effective retinotomy with proper tamponade

during vitrectomy may obviate the requirement of concurrent SB, resulting in less surgical time, cost, and morbidity.³²⁻³⁴

This series is limited by its retrospective and noncomparative nature. In addition, the sample size was small. A limited sample size may be a plausible explanation for the nonsignificant

associations in this study. Despite these limitations, this study has an acceptable sample size in comparison to the previous studies.

In conclusion, our findings reinforce the value of retinotomy incisions in managing RRD-associated PVR. We could not find statistically significant associations between multiple factors assessed in this study and the recurrent RD rate and BCVA. Further prospective studies on the outcomes of retinotomy are recommended.

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Conflicts of interest

There are no conflicts of interest.

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